DOCUMENT RESUME

ED 441 329 EF 005 712

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TITLE The Impact of School Building Condition and Student Achievement, and Behavior.
PUB DATE 1998-11-00
NOTE 26p.; Paper presented at the European Investment Bank/Organization for Economic Coordination and Development International Conference, (Luxembourg, November 16-17, 1998).
PUB TYPE Information Analyses (070) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; *Educational Environment; *Educational Facilities Improvement; Elementary Secondary Education; Parent School Relationship; Public Schools; *Student Behavior

ABSTRACT

This paper examines study findings on the relationship between the educational facility and the student variables of academic achievement and student behavior, revealing the extent that thermal environment, proper illumination, space, and equipment and furnishings have on students. Additionally discussed is the relationship between parental involvement, school building conditions, and student achievement. In almost all cases, the better the built environment is, the more positive the impact on students' test scores is: test scores between students in substandard buildings compared to students in better school environments differed by 5 to 17 percentile points. Also, in cases where there was greater parental involvement in fundraising for school purposes, the school buildings were in better condition. The conclusion is that money spent on school building improvement is money well spent. While it is known that better prepared graduates of the local school system are more productive citizens, the degree of influence the school environment has on later life remains unknown. (GR)

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THE IMPACT OF SCHOOL BUILDING CONDITION AND STUDENT ACHIEVEMENT, AND BEHAVIOR

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Presented at the International Conference
The Appraisal of Educational Investment
European Investment Bank/Organization for Economic Coordination and Development
Luxembourg
16-17 November 1998

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Introduction

One of the most provocative and compelling questions regarding school buildings is the influence the built environment has upon the performance of students and teachers. Common belief held by educators and architects is that the building does indeed have an influence upon how well students and teachers perform. The big question, however, is the degree of influence and how can that be accurately measured.

Over the past sixty years, considerable research has taken place in the United States to assess the possible relationship between student performance and built environment. Researchers have mounted studies to investigate the influence of various building components such as wall color, building configuration, the presence or absence of windows in classrooms, air-conditioning, space allocation per pupil, use of carpeting on the floor, noise levels, thermal conditions, and furniture types upon student performance in an effort to discover a relationship. For the most part, these research efforts have proven very valuable to the designers of new school buildings. Most new school buildings in the United States incorporate the best features in the above list because of the research efforts.

From that body of research findings, considerable improvement in the type of new school buildings have resulted. Students and teachers obviously have benefited from this infusion of research findings in new buildings. Yet the majority of students in the United States are not housed in new school buildings. The vast majority of students are in older buildings, many of which are approaching 50 years of age. These buildings do not, for the most part, have the essential components that have been found to be necessary for a good learning environment. As a result of this situation, research exploring the relationship between building condition and student performance is important.

A problem that is inherent in this research is the lack of predictability on results. In the hard sciences, predictability resulting from scientific investigation is almost a given; yet in the social sciences, predictability is very

difficult at best to demonstrate. The research discussed in this paper in no way can result in predictability. There is, however, benefit that can be derived from examination and use of the research findings in these studies. One major deficiency in research on school facilities has been the lack of replication of sound studies. The studies presented here show the beginning of a progression of studies using the same methodology, but with different populations. These studies may be the start of discovering some generalities regarding the impact of buildings on student performance.

In recent years, there have been some research studies completed that have shown a promising avenue of investigation. These studies have demonstrated a positive relationship between student achievement and behavior and the design and condition of school buildings. There have not been sufficient numbers of such studies; however, to present a strong relationship from which generalizations can be made. Even the individual studies that are in existence show a low to medium level of relationship between these variables. Nevertheless, there is a high degree of interest in this area of research to justify a more intense effort to gather whatever data are available on this relationship. People want to know if the built environment has an effect upon user performance, especially upon students in school buildings. Some researchers state that the building has such insignificant influence upon the user that whatever influence may be found to exist, is simply that of chance. Other researchers, however, state that the built environment does have a discernible influence upon the process of teaching and learning. These individuals state the users are influenced both positively and negatively by how the built environment either permits them to function or inhibits the process of teaching and learning, yet systematic analysis of this question on a scale large enough to generalize or predict has not been undertaken.

The main emphasis of investigation in this paper is the relationship between the built environment and at least two student variables. The first

variable is student achievement as measured by some form of standardized or normed test or examination administered to all students in the schools. The other variable is student behavior that can include a specific level of student activity or school climate that is a more general term. These two variables relate directly to students themselves. There is a common belief among educators that the behavior of students influences their academic achievement. The reverse of this relationship is also believed to be true.

Building Age and Achievement

Conventional wisdom in the area of educational facility planning and design seems to indicate that the physical environment does indeed have an effect upon the behavior and performance of the students and teachers who occupy these spaces. So often, however, a significant relationship is difficult to statistically demonstrate. To explore this possible relationship, Bowers and Burkett investigated the differences in student achievement, health, attendance, and behavior between two groups of students in different physical environments (1988). Two elementary school buildings, containing students between the ages of 5 to 13 years, in the same school jurisdiction in rural Tennessee were used to differentiate physical environments for this comparison. One school was recently opened and was a modern building in all respects. The other building was constructed in 1939 and had very little improvement to the physical structure. The researchers reasoned that the students and faculty in both buildings were essentially the same. The educational program and teacher competency was exactly equal. Students in the fourth and sixth grades were tested to determine the degree of academic achievement. Students in the new school building significantly out performed the students in the older building in reading, listening, language, and arithmetic. Further, faculty in the new building reported fewer disciplinary incidents and health conditions than faculty in the old building. Attendance likewise was better with those students in the new building than in the old school. Bowers and Burkett concluded that a relationship did exist between

the physical environment and student achievement, health, attendance, and behavior.

In a very recent replication of the above study, Phillips (1997) found significant differences in the reading and arithmetic scores between students in new buildings than those students in old buildings. He found a definite relationship between the age of the school facility and student reading achievement scores as measured by the Iowa Test of Basic Skills and a strong relationship between student mathematics achievement scores and building age. The mean mathematics scores for the treatment group (those students in new buildings) increased 7.63 percentile ranks after moving into the new facility. He did not find any significant differences in attendance patterns between the students enrolled in the old or new buildings.

Building Condition and Parental Involvement

Edwards investigated the relationship between parental involvement, school building condition, and student achievement in the schools in Washington, D.C. (1992). She hypothesized that the condition of public school buildings is affected by parental involvement and that the condition of the school building further affects student achievement. She analyzed these relationships by evaluating the condition of school buildings, determining the extent of parental involvement and the amount of funds parents raised for the local school, and compared the results with student achievement scores.

She used data from a self-evaluation of school facilities completed by a group of volunteers in each community to determine the condition of the building. The sample buildings were classified into three categories: poor, fair, or excellent condition as a result of the evaluation. The classification of the buildings in the various categories was based upon the presence or absence of physical conditions. For instance, buildings that had roofs that leaked, classrooms with peeling paint, lacked air-conditioning, were not clean, and needed repairs were grouped into the poor category.

For parent involvement, Edwards used membership in the Parent-Teachers Association (PTA) on a per student basis plus the PTA budget at the school on a per student basis. Student achievement was measured by using average school scores on the Comprehensive Test of Basic Skills (CTBS) which was administered to all three levels of schools by the Washington, D.C. Public Schools. The average CTBS score of students in each school was obtained through standard published reports (p. 13).

For the first part of her hypothesis dealing with parental involvement, Edwards found that in those schools where large numbers of parents were involved through membership in the PTA and who raised considerable funds for school purposes, the buildings were in better condition than those buildings where parents were less involved in school activities and who raised less money for school purposes. For every dollar increase in the PTA budget of the school, the building was seen to improve on the scale of building condition. In this model of analysis, she found four variables that had significant results in predicting the changes in building condition. These were: types of school (elementary, junior, senior high), age of building, student enrollment, and mean income of the community in which the school is located. The first three of these variables have significant results in predicting the changes in building condition. Although the mean income factor was not significant, the parameter estimate was positive, which indicates that as the mean income of the area increases, the building condition improves.

The second part of the hypothesis dealing with building condition and student achievement, the analysis of data supported the hypothesis. Building condition did have an affect upon student achievement scores. The analysis indicates that as a school moves from one category to another, the achievement scores can be expected to increase by 5.455 percentage points. If the school moves two categories, such as from poor to excellent, the achievement scores would be expected to increase by 10.9 percentage points in the average achievement scores. Conversely, based upon the analysis, "the signs of the

estimated building condition coefficients are negative, meaning that from our base of excellent schools, a building condition of fair or poor [school buildings] will reduce the average student achievement score" (p. 24).

Building Condition and Achievement

In a similar study, Cash investigated the relationship between certain school building conditions, student achievement, and student behavior in rural high schools in Virginia (1993). Basically, the same hypothesis that Edwards employed was used in conducting this study. The condition of the building in this study, however, was the independent variable and student achievement and behavior served as dependent variables.

The condition of the school building was determined through evaluation by local school system personnel. Cash developed a building evaluation instrument to be used by local school personnel to determine the classification of the building. This instrument was based upon existing research studies that addressed certain building conditions. Each item on the instrument was derived from previous studies that had been completed and which showed a positive relationship between a particular building condition and student achievement and behavior. The items in the Commonwealth Assessment of Physical Environment (CAPE) addressed such conditions as: air conditioning, classroom illumination, temperature control, classroom color, graffiti, science equipment and utilities, paint schedules, roof adequacy, classroom windows, floor type, building age, supporting facilities, condition of school grounds, and furniture condition. Each of these conditions has been shown by previous research to be related to student achievement and behavior. The presence or absence of these factors determined the overall condition of the building. Buildings were classified as substandard, standard, and above standard through the local self-evaluation.

In addition to these evaluative condition classifications, the 27 items on the CAPE were divided into two categories: structural factors and cosmetic factors. Thus, some items related to the structure of the building such as

classroom lighting, air conditioning, thermal environment and roof integrity. Other items such as painting schedules, color of the walls, cleanliness of the building, and presence of graffiti related to the cosmetic condition of the building. These two major categories were used to analyze different sections of the CAPE with student achievement scores; however, student achievement scores were compared to the combined 27 items on the instrument to produce an overall building condition category. Thus, three comparisons were made with student achievement scores: overall, cosmetic, and structural. Figure 1 lists the items in the two categories.

STRUCTURAL AND COSMETIC CATEGORIES
ON THE BUILDING APPRAISAL INSTRUMENT

STRUCTURAL BUILDING ITEMS	COSMETIC BUILDING ITEMS
Building Age	Classroom Paint
Windows in Classrooms	Interior Paint Cycle
Type of Flooring	Exterior Wall Paint
Type of Classroom Heating	Exterior Paint Cycle
Air Conditioning	Floors Swept
Roof Leaks	Floors Mopped
Adjacent Facilities	Presence of Graffiti
Locker Conditions	Graffiti Removal
Ceiling Material	Classroom Furniture
Science Lab Equipment	School Grounds
Science Lab Age	Landscaping
Classroom Lighting	
Wall Color	
Exterior Noise	
Student Density	
Site Acreage	

Figure 1

Within these categories, the evaluative classification of the building was used for comparison purposes. Inter-rater reliability for building evaluation was established through a comparison of the ratings of buildings completed by school system personnel and the results of an evaluation of a sample of the buildings contained in the study by the researcher.

Student achievement was measured by use of scaled scores of students taking the Test of Academic Proficiency (TAP) which was administered to all 11th grade students in Virginia. The average school score for these high schools was used in the study. The scaled scores can be used to compare success on different sub-tests of the TAP. In addition, the ratio of students receiving free and reduced lunches was used to control for socio-economic status (SES) of the school attendance area. In addition, Cash used the Virginia Composite Index, which is a measure of local fiscal capacity, to control for the wealth of the school jurisdiction.

Student behavior was measured by the disciplinary incidents reported to the Virginia Department of Education and the number of suspensions and expulsions of students by local school administrators for the year. The disciplinary incidents, suspensions, and expulsions were converted to a per student ratio for comparison purposes. These data were used to test the hypothesis that building condition effects student behavior.

The analysis of data was done by means of comparison of achievement score means among building condition ratings using analysis of covariance to adjust the means. The percentage of students who did not qualify for free or reduced lunch was the covariant. This factor served to adjust the means for socio-economic status to reflect the status of the students. The adjusted mean scale scores in achievement and the behavior ratios for each building were compared across the three levels of building condition and between the three levels of overall, cosmetic, and structural categories.

The results of this comparison indicated there were differences between the achievement test scores of students in below standard and above standard buildings. These differences were displayed in table form showing the school mean score on each sub-test and the appropriate percentile ranking of that score. Thus, if the mean score for all of the students for example in below standard schools were 185, the percentile rank for this score would be 47. For all students in the above standard school buildings, the mean for the same

sub-test would be 188. This mean score would fall into the 51st percentile rank. A simple comparison between the two percentile ranks would indicate a difference of 4 points in favor of the students in above standard buildings. The interpretation of this would be that students in sub-standard buildings performed less well than the other students.

All of the sub-tests in the achievement test were similarly displayed so that a comparison between the percentile ranks could be made for both groups. This resulted in a more simplistic, but dramatic comparison between the test results of the two student groups. Table 1 presents data regarding the comparison of percentile ranks and shows how the differences in the ranks were achieved.

As can be seen in the table for the composite of the scores, the students in below standard buildings had a mean score of 187 that fell into the 47th percentile ranking. Conversely, the mean score for students in above standard buildings was 190 that were in the 52nd percentile rank. This difference is then reported in Table 1 to describe the scores between each group of students. The analysis of differences in percentile rank follow this pattern in that difference between each group of students is compared.

Table 1

Comparison of Achievement Scale Score Means and Percentile Ranks on the Sub-tests of the TAP* and Building Condition

OVERALL BUILDING CONDITION

	Substandard		Above Standard		
Achievement Subtest	Means	PR**	Means	PR	Difference
Reading	185	47	188	51	+4
Mathematics	179	43	181	47	+4
Written Expression	191	57	193	59	+2
Sources of information	189	48	193	52	+4
Basic Composite	186	49	189	53	+4
Social Studies	190	48	192	51	+3
Science	190	50	193	55	+5
Complete Composite	187	47	190	52	+5

* Test of Academic Proficiently
** Percentile Rank
Note: Scale Score means have been adjusted for socioeconomic status. Percentile ranks have been derived from scale score means that have been adjusted for socioeconomic status.

The results of the analysis indicated a positive relationship between building condition and achievement of students. In all of the subtests of the TAP, academic performance was positively related to the condition of the school building. Cash found that student achievement was higher in those buildings with higher quality ratings. The difference in percentile rankings on the composite test score was as much as 5 percent in all three categories. The comparison between the overall building category and achievement had higher levels of achievement in the sub-tests than when the cosmetic and structural building category was compared with achievement. Student achievement in the science section of the TAP was higher in those buildings with better quality science equipment than in those buildings with lower quality science facilities. The difference between low and high rated schools was five percentile rank

points. Table 2 shows the differences between the percentile rank of the school mean scores for students in substandard and above standard buildings. These data are displayed for each category.

Table 2
DIFFERENCES OF ACHIEVEMENT PERCENTILE RANK SCORES OF STUDENTS IN SUB-STANDARD AND ABOVE STANDARD BUILDINGS

Carol Cash Study

Subject Areas	Overall	Cosmetic	Structural
Reading	+4	+3	+2
Mathematics	+4	+4	0
Writing	+2	+2	+1
Source of Information	+4	+4	+4
Basic Composite	+4	+4	+4
Social Science	+3	+3	+3
Science	+5	+5	+5
Composite	+5	+5	+5

For the comparison between student behavior and building condition, there was a positive relationship, but in a reverse manner. The better quality schools had higher ratios of disciplinary incidents, expulsions, and suspensions than did schools with low building conditions. This reverse relationship was not explicable by the data, but Cash theorized that the faculty in the better quality schools was perhaps stricter in the application of disciplinary policy than faculty in lower rated buildings with a resulting higher incidents reported.

A similar study on a statewide basis was conducted by Earthman, Cash, and Van Berkum (1995). The researchers used the same methodology as the Cash study. The study was conducted in North Dakota and included all 199 high school buildings in the state. North Dakota was selected for the study site because traditionally students as a whole score among the highest in the nation on the Scholastic Achievement Test. North Dakota students also scored third highest in the International Comparison of 8th Grade Math scores in 1992 behind only Asia and Japan (Leadership News, 1994). Additionally, the

state has a relatively homogeneous population that is mostly rural. North Dakota seemed like an excellent site for the logical extension of the Cash research.

The building condition rankings were done using the State Assessment of Facilities in Education, which was a modification of the original instrument from the Cash study. Again a local self-evaluation methodology was utilized to obtain the rankings of substandard, standard, and above standard buildings. In addition, the items of the instrument were categorized to create cosmetic and structural categories for comparison purposes in the same manner as the Cash study. In this way, three comparisons were made: overall, cosmetic, and structural categories.

Student scores on the Comprehensive Test of Basic Skills (CTBS) administered to all 11th graders throughout the state was used for student achievement. Again, scaled score means for each building was the measure used for comparison purposes. In all but one sub-test of the CTBS, the students in above standard buildings outscored students in the substandard buildings. There was no difference in scores on the Social Studies sub-test between the building conditions, and minus five points when the structural category items were used for comparison. The range of differences in the scores in all other sub-tests between the two building conditions was from 1 to 9 percentile ranks. The differences in the percentile rank scores of student achievement are displayed in Table 3.

When the cosmetic building category was compared with achievement, the differences in percentile rankings were exactly the same as the other two categories, except in social science where a positive difference was observed.

Table 3

Differences Between Percentile Rank Scores of Students in Substandard and Above Standard Buildings

Earthman et al Study

Subject Area	Overall	Cosmetic	Structural
Reading Vocabulary	+7	+7	+7
Reading Comp	+1	+1	+1
Math Concepts	+1	+1	+1
Math Application	+3	+3	+3
Language	+4	+4	+4
Spelling	+9	+9	+9
Social Science	0	+4	-5
Science	+7	+7	+7
Composite Score	+5	+5	+5

Although the differences in the composite score were exactly the same as the Cash study, there are some notable differences. The CTBS has additional sub-tests the TAP does not have such as reading vocabulary, mathematics concepts, and spelling. The differences in reading vocabulary and spelling are rather high, considering the differences in other sub-tests. The North Dakota study does support the findings of both the Edwards and Cash studies. Both of these researchers found at least a 5 percent difference in composite achievement scores in their population. The North Dakota study resulted in a similar difference of percentile rankings in student achievement scores.

A comparison of student behavior and the three rankings of the building were made to explore a possible relationship between these variables. The total number of disciplinary incidents per school was very small in all schools throughout the state. As a result, the comparison figures are extremely small and in some cases meaningless. Nevertheless, students in the above standard buildings recorded fewer disciplinary incidents than those students in the substandard buildings when comparisons were made on the overall and

cosmetic conditions of the building. When the structural building condition was used as a measure of comparison, however, the results were somewhat different. Students in above standard buildings had more disciplinary incidents than students in below standard buildings. This latter finding is exactly the same as what Cash found in her study. The first two comparisons, however, are directly opposite of her findings.

A third study using the same basic methodology of the Cash study was recently completed using large, urban high schools in Virginia as the population. Hines used the same methodology and data gathering instrument that Cash used on small, rural high schools (1996). His results in comparing building condition and student achievement were basically the same as hers. The range of his differences between substandard and above standard buildings, however, were greater than what was found in her study of rural high schools and in the North Dakota high schools study. Some of the differences were as high as 17 percentile rank points. This compares favorably with the results Edwards got in her comparison between the worst and best school buildings. Edwards stated that the difference in mean achievement scores for her study population was as much as 10.9 percent between school buildings in the substandard and above standard categories (p. 24).

The Hines study is an extremely valuable source of findings regarding the differences in achievement between students in substandard and above standard buildings. His analysis indicated that in five sub-tests the range of differences was eleven or more points, while in the remaining sub-tests the range of differences was nine points each. The difference in composite scores was as much as 14 points. Data regarding his comparison regarding student scores are found in Table 4.

Table 4
DIFFERENCES OF ACHIEVEMENT PERCENTILE RNAK SCORES OF STUDENTS IN SUB-STANDARD AND ABOVE STANDARD BUILDINGS

Eric Hines Study

Subject Areas	Overall	Cosmetic	Structural
Reading	+15	+5	+8
Mathematics	+17	+4	+9
Writing	+ 9	+4	+5
Source of Information	+13	0	-1
Basic Composite	+13	+5	+7
Social Science	+11	+4	+7
Science	+ 9	+5	+7
Composite	+14	+6	+9

Differences of this magnitude are very important to researchers. Not only do these findings corroborate the findings in previous studies, but also they severely challenge the proposition that the building does not make a difference in student performance. These findings push the limit of variance of student performance that can be attributed to the physical environment to a new level. Differences in student scores as large as these are enough to account for student success or failure.

The Hines study is the latest and most dramatic in a series that were completed by researchers trying to explore the relationship between school building condition, student achievement, and student behavior. The basic methodology was the same for all four studies and the results seemed to be consistent. The only difference between the results of the studies seemed to be in the degree of difference in the mean scores of achievement examinations between schools in the lowest category and those in the highest. One might conclude from these studies that indeed the building does contribute to the variance in student performance. The degree of this contribution may vary, but is constant and the results of each study supports the other studies.

Comparison of Findings

Three of the six correlation studies cited above (Cash, Earthman, and Hines) used the same methodology and data-gathering instrument. Although the standardized test in the North Dakota study was different from the Test of Academic Proficiency used in the studies completed by Cash and Hines, there are similar sub-tests that can be used for comparison. Tables 5, 6, and 7 contain data regarding the differences in achievement percentile rank scores of students in substandard and above standard buildings for the three studies.

Table 5
DIFFERENCES OF ACHIEVEMENT PERCENTILE RANK SCORE OF STUDENTS IN SUBSTANDARD AND ABOVE-STANDARD BUILDINGS

OVERALL

Subject Areas	Cash (TAP)* 1993	Earthman et al (CTBS)** 1995	Hines (TAP) 1996
Reading Vocabulary	--	+7	--
Reading Comprehension	+4	+1	+15
Math Concepts	--	+1	--
Math Application	+4	+3	+17
Language/Writing	+2	+4	+ 9
Sources of Info	+4	--	+13
Basic Composite	+4	--	+13
Spelling	--	+9	--
Social Science	+3	0	+11
Science	+5	+7	+ 9
Total Composite	+5	+5	+14

* = Test of Academic Proficiency
** = Comprehensive Test of Basic Skills

Table 6
DIFFERENCES OF ACHIEVEMENT PERCENTILE RANK SCORE OF STUDENTS IN SUBSTANDARD AND ABOVE-STANDARD BUILDINGS

COSMETIC

Subject Areas	Cash (TAP) 1993	Earthman et al (CTBS) 1995	Hines (TAP) 1996
Reading Vocabulary	--	+7	--
Reading Comprehension	+4	+1	+5
Math Concepts	--	+1	--
Math Application	+4	+3	+4
Lang/Writing	+2	+4	+4
Sources of Info	+4	--	0
Basic Composite	+4	--	+5
Spelling	--	+9	--
Social Science	+3	0	+4
Science	+5	+7	+5
Total Composite	+5	+5	+6

Table 7
DIFFERENCES OF ACHIEVEMENT PERCENTILE RANK SCORE OF STUDENTS IN SUBSTANDARD AND ABOVE-STANDARD BUILDINGS

STRUCTURAL

Subject Areas	Cash (TAP) 1993	Earthman et al (CTBS) 1995	Hines (TAP) 1996
Reading Vocabulary	--	+7	--
Reading Comprehension	+4	+1	+8
Math Concepts	--	+1	--
Math Application	+4	+3	+9
Lang/Writing	+2	+4	+5
Sources of Info	+4	--	-1
Basic Composite	+4	--	+7
Spelling	--	+9	--
Social Science	+3	0	+7
Science	+5	+7	+7
Total Composite	+5	+5	+9

Analyses of these data would indicate first of all that all three studies found a difference in the percentile rank scores of students in the various buildings. In each case the differences were positive. Further the findings in these studies corroborate the findings in previous studies. Specifically, the findings indicate that in four main subjects of the curriculum of the public schools, reading, mathematics, language/writing, and science, there is a difference in student performance.

All of the three studies cited above used a factor of building condition to classify school buildings for analysis purposes. The building condition factor was used to classify buildings into sub-standard, standard, or above standard categories depending upon how the building was evaluated. In all of the studies, the building factor was made up of responses to questions relating to certain attributes or conditions in the building.

Every question in the evaluative instrument was about building attributes and conditions that were individually identified in previous research studies to be directly related to either student achievement or student behavior. For instance, studies were completed using such separate building factors as air conditioning, level of illumination, presence of windows in classrooms, availability of modern science equipment, floor material, or wall color as a variable with which to compare student achievement. The next logical and higher level step in this research was to incorporate the important building conditions into a single building condition factor. Thus, the building condition classification stood for or represented a number of conditions that a school building in good condition possessed or would possess. This factor was then used to compare student achievement and behavior with the condition of the school building. The building condition factor seems to be an important concept used in more recent research on the relationship between school building and student achievement and behavior.

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Summary

All of the studies cited above have demonstrated a relationship between student performance, both achievement and behavior, and the condition of the built environment. The depth of the relationship has varied, but the most recent study completed demonstrates a much stronger degree of relationship than previously thought existed.

Some of the most important building factors that influence learning are those that relate to control of the thermal environment, proper illumination, adequate space, availability of equipment and furnishings, especially in the subject area of science.

The range of difference in each of these four studies between the test scores of students in substandard and above standard school buildings was between 1 and 17 percentile points, but nevertheless, in almost all cases there was a positive difference for students in the better buildings. These findings are of particular importance because of the large number of school buildings across the United States that are in substandard condition. The factors which determined the condition of buildings in these studies are usually incorporated in a new structure, but the vast majority of the existing school buildings do not have the benefit of these conditions, as witness the General Accounting Office study which documented the poor state of condition of the public schools in the United States (1995).

The results of these all studies cited in this paper can be played out in possible actions of school authorities and governing board members to improve the educational opportunities of students. If, as the studies strongly indicate, the test scores of students in above standard school buildings are above the scores of students in substandard building by as much as 5-17 percentile points, then there are ways of increasing student performance and subsequent test scores by improving the condition of the building. Spending funds to improve the built environment might produce greater student performance results than funds spent on instructional materials, textbooks, and even

teachers. The results of these studies at least strongly suggest this proposition.

There are limitations to research in the effect buildings have upon students, and of course, the major limitation on this type of research is determining the degree to which school facilities can be the actual cause of student behavior and achievement. When one realizes the many variables that influence how much students can and do learn and how students behave, it is evident the built environment perhaps has a very limited role to play. Obviously, the most important variables that influences how students learn come from the genes their parents impart to them and the home environment they create for their children. Then in descending order are variables such as community surroundings and conditions beginning from the day of birth to the very day the student enters the school building that subsequently influence the activities of students. Only then can the school building play any part in how students learn. Depending upon what expert in learning theory is read, the amount of variance the built environment plays in influencing learning and behaving is either non-existent or at best is limited. Even if the variance the built environment can account for is slight, the important fact to remember is that a portion of the variance can then be controlled through efforts of school authorities and design professionals.

The condition of the school building is something over which school authorities have some degree of control. They can insure that buildings are in good condition and present the best possible learning environment. Or the school authorities can let the condition of the buildings deteriorate to the point of influencing the educational opportunities of students under their charge. That is a very heavy responsibility to bear, yet the resultant condition of school buildings speak very loudly.

A confounding dimension to these studies, however, is the long-term influence a poor building may have upon students. The longitudinal influence of the physical environment could be a very important consideration. If

students are housed in poor buildings for a number of years, will the effect on achievement be multiplied? Moreover, will the aesthetic values of the students be impaired? After long exposure to poor or marginal buildings, will students believe such conditions are normal? It is very difficult to conduct longitudinal research studies on the influence of a building. As a result, we can not with any degree of certainty describe the results of this phenomenon. But the research cited here is simply a photograph of conditions and relationships in one period of time, not over successive periods of time. There may indeed be a cumulative effect upon this disparity in student test scores between poor and good school buildings that continue during the time the student is in school.

There is also the matter of equity of educational opportunity when certain students attend school in buildings of lesser quality than other students. If students in poor buildings perform 5-17 percentile rank points less than other students, they certainly are at a disadvantage. This is especially true when future education relies so heavily upon past performance. Students in poor buildings will not have the same opportunity as other students in better school buildings.

It has been demonstrated time and again that better prepared graduates of the local school system are more productive citizens. Better-prepared graduates have more productive jobs throughout their lives and in turn are happier. Of course, the corollary to this is that more productive citizens add to the prosperity of the state and support it more evenly through taxes. Consequently, anything that can be done to positively raise the level of achievement of students who will be future citizens, will greatly influence the economy over time.

The discussion in this paper leads one to the knowledge that the school building does have an influence upon how a student performs. Few individuals actually question this statement. There may, however, be questions as to the degree of influence. The correlation studies cited here seem to give a glimmer

into the possibilities of further studies to investigate this important relationship between school buildings and student achievement and behavior.

There seems to be five major premises that should be kept in mind regarding the findings of these studies.

1. School buildings may account for as much as 5 to 17 percentile rank points in student achievement scores and these differences are very dramatic.
2. There may be a cumulative effect to the disparity in student achievement scores between students in above standard and below standard buildings. This is an imponderable that may have severe repercussions on the learning of students
3. Within many school districts and throughout the state, there may be an equity issue if some students are housed in poor buildings and other students are located in above standard buildings. Students in poor buildings may be disadvantages so long as they are in such buildings.
4. There is a definite economic value attached to improving school buildings if building conditions influence the level of student achievement.
5. The condition of the building is something over which school authorities can have some control to improve.

These premises alone are sufficient for decision-makers to improve school buildings to provide better educational opportunities for students. The local school jurisdictions in the United States are not constructing as many new school buildings as they did in previous decades. In spite of the fact there is a recent surge of new students that will increase the need for new schools, the vast majority of students still attend school in old buildings that are not safe, functional, or efficient. These buildings were constructed many years ago and now are in poor condition. We have a large investment in the current building inventory in every state. This inventory of investment needs to be preserved and improved. Many other countries throughout the world are in similar situations concerning their school building inventory. It is incumbent upon

school authorities and governing boards in every jurisdiction to heed the results of research to make certain all students under their charge are in physical surroundings that provide them with the best opportunity to achieve a good education. In this manner schools can positively contribute to the preparation of productive citizens and the consequential strengthening of the economy of the country.

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